Docket: P/121-2

WEB FOLDING AND SOLUTION DISPENSING SYSTEM

Field of the Invention

A web folding and solution dispensing system.

Background of the Invention

US Patents 6,196,147 and 5,572,940 relate to an apparatus and method for converting a roll of material into various products such as curtains, draperies and valances. The apparatus includes a roll let off for supporting and feeding a roll of material or cloth. After the let off, the edges of the cloth are cut if desired and are engaged by a pair of edge folding and positioning stations for forming vertically folded edges. The folded edges are then converted into hems and sewn into the material by a pair of corresponding hem sewing heads and cloth advancers. Once vertical hems are formed in the cloth, the cloth is cut to predetermined lengths and if desired, folded in a predetermined pattern.

US Patent 5,816,434 relates to a sheet folding device that enables a single operator to fold bed sheets, bed spreads, tablecloths and other sheet-like materials. The device employs a sheet clutching clamp and a folding bar both attached to a mounting plate. Placement of the mounting plate onto any vertical surface accommodates articles of different sizes. The folding bar is the element about which a fold is made. A 90 degree hook with an elastomeric sleeve is effective for this task. The invention can be mounted to a wall, mobile cart or any vertical surface. To fold a sheet, an operator slides a portion of the sheet, such as a corner, into the spring clip. With simple manual manipulation, employing the spring clip and folding bar, the folding operation is completed without risk of the sheet touching a soiled floor.

US Patent 5,634,875 relates to a folding machine, which includes a vacuum conveyor and a plurality of flip folders spaced along the length of the conveyor. A length of sheet material is fed downstream along the conveyor to position the lead end of the sheet in clamp members at a

first flip folder. The end is clamped and rotated downstream and up above the remainder of the sheet which is continuously fed down the conveyor. The clamps are released to allow the lead end to fall over the trailing edge of the sheet, thereby completing a first fold which reduces the length of the sheet 50 percent. Successive lead ends of the sheet are folded by second and third flip folders to reduce the length of the sheet to 1/8 the length of the original sheet and increase the thickness of the sheet to eight plies. The final folded bundle is fed to a tuck folder which further reduces the length of the package 50 percent forming a folded package 1/16 the length of the original sheet and having 16 plies.

US Patents 5,197,722 and 5,363,784 relate to a cloth folding device with an air blower for uncurling ends. The device picks up, turns over, folds and aligns a sleeve cloth that is continuously carried by a moving conveyor. The device comprises a jaw located above the upper surface of the moving conveyor and a lifting blade located below the bottom surface of a moving conveyor. The leading edge of the sheet cloth is detected by a sensor that triggers the lifting blade to push a front portion of the cloth up and into the jaw which holds the cloth as the conveyor continues to move. The cloth is folded and aligned by the action of the conveyor belt and a first blower, which blows air on a topside of the cloth, and a second blower, which blows air on a bottom side of the cloth.

US Patent 4,154,180 relates to a cutting and hemming system. Cloth moves from a reel along its length, a first right handed edge treatment system positioned at one edge of the path of movement of the cloth treats one edge of the cloth, the cloth is turned over and a second right handed edge treatment system positioned at the edge of the path of movement treats the opposite edge of the cloth. The cloth then moves into a cutting station where the cloth is cut into smaller sections. The cut sections are moved along an L-shaped path by a conveyor system with the cut edges extending along the path and a third "right handed" edge treatment system positioned

adjacent the first leg of the L-shaped path treats one cut edge of the sections, the sections are turned over as they move into the second leg of the L-shaped path, and a fourth right handed edge treatment system treats the opposite cut edge of the sections. The sections are then stacked.

US Patent 5,058,517 relates to a work piece folding device for a sewing machine which can fold the peripheral edge of a fabric such as pocket cloth, comprising a gage plate on which the pocket cloth is placed, a press plate superimposed on the gage plate for folding down the edge of the cloth along the contour of the gage plate, a folding pieces support member surrounding the periphery of the gage plate, a plurality of folding pieces provided on the folding pieces support member and shifted between two positions: an operational position under the gage plate for folding down the peripheral edge of the cloth and a preparatory position apart from the gage plate, and a plurality of pinching pieces for pinching the gage plate, the cloth and the press plate in cooperation with the corresponding folding pieces in the operational position.

US Patent 5,915,319 relates to a hemming and seaming machine having a hemming conveyor on which a workpiece is moved along a path of travel toward and through a hemming station, which sews a hem in the workpiece, is disclosed. The hemmed workpiece is then moved downstream to a folding station where a spaced series of first air jets selectively emit streams of air between a folding plate and clamping plate to create a vacuum therebetween to draw the leading edge of the workpiece off of the hemming conveyor and between the folding plate and the clamping plate. The leading edge of the workpiece is held between the clamping and folding plates while the workpiece continues to move along the path of travel. After a predetermined period of time has elapsed from the detection of the leading edge of the workpiece, or in response to the detection of the trailing edge of the workpiece, the leading edge of the workpiece is released from between the folding and clamping plates. The workpiece is then moved to a

downstream seamer station, which sews a seam in the workpiece, and then to a downstream workpiece stacking station.

US Patent 4,231,238 relates to an apparatus for the liquid treatment of cloth consisting of a U-shaped liquid tank for a treating liquid, a cloth inlet passage and a cloth outlet passage located in the tank and each having a relatively narrow spacing between vertical endless net conveyors which define the opposed sides of the passages. A plurality of liquid jet nozzles are provided along the cloth passages to spray a treating liquid against a cloth so that the cloth collides alternately with the conveyers on the opposite sides of each passage. Another cloth passage is located in the treating liquid below and forms a connecting passage between the cloth inlet-and outlet-passages. The cloth passes in a folded zigzag state through the other cloth passage. This apparatus is particularly suitable for the liquid treatment of an easily expandable cloth such as the knitted cloth by piling a plurality of the sheets thereof en bloc.

Summary of Invention

The present invention relates to a method for web folding and wetting comprising dispensing webs from roll unwind stands. The webs are fed to the system at continuous speed from S-Wrap drive rollers. The webs are then passed over wetting tubes where wetting solution is dispensed onto the webs. The webs are then passed onto folding plates where the webs are folded into "Z", "C", or "W" or "e" fold configurations. It is an object of the present invention for the webs to be used for cleaning and/or hygienic wiping. It is an object of the present invention for the method to further comprise cutting the webs into appropriate lengths.

It is an object of the present invention for the method to fold and wet eight continuously moving webs of an absorbent material such as cloth, non-woven fabric, tissue paper or the like. It is an object of the present invention for the method to further comprise dispensing a web of

packaging material such as closed-cell foam, plastic sheet or other suitable material; slitting score lines into the packaging material and wrapping the folded and layered webs.

It is an object of the present invention for the web speed to be adjustable over a finite range such as from about 180" per minute to 900" per minute. It is an object of the present invention for the flow rate of the wetting solution to be automatically adjusted by a control system to compensate for changing web speeds. It is an object of the present invention for the control system to monitor and control flow rates of the solution dispensed. It is an object of the present invention for the webs to be weighed on line after the wetting solution is dispensed on the webs to verify that the correct amount of fluid has been added to the webs.

The present invention relates to a system for folding and wetting webs of absorbent material comprising: roll unwind stands, S-Wrap drive rollers, stationary wetting tubes guide rollers and folding plates. It is an object of the present invention for the system to be portable with clamp locking casters. It is an object of the present invention for the system to comprise up to eight quick change folding plate assemblies. It is an object of the present invention for the system to further comprise a razor-slitter/anvil roll assembly or other suitable mechanism to score a web of suitable packaging material for wrapping the folded and layered webs. It is an object of the present invention for the system to further comprise a surge tank for holding solution pumped from a storage tote, tank, or drum which allows for changeover of storage containers without interrupting operation of the system.

The present invention relates to an integrated system to manufacture pre-moistened web strips which, when cut into appropriate lengths, are commonly used for cleaning and/or hygienic wiping. The web folding and wetting system simultaneously folds and wets up to eight continuously moving webs of absorbent material. Webs of various widths, dispensed from Roll Unwind Stands, are fed at continuous speed via S-Wrap Drive Rollers, passed over Wetting

Tubes dispensing wetting solution, and through Folding Plates to fold the wet webs into "Z", "C", "W" or "e" fold configurations. The system can also dispense a web of packaging material such as closed-cell foam, plastic sheet or other suitable material, slitting score-lines into same, to longitudinally wrap the folded and layered webs.

The Solution Dispensing System automatically controls and meters the dispensing of solutions from each port of an eight port manifold at a settable rate ranging from about 0.04 to 1.15 gallons per minute. With a web speed ranging from about 180 to 900 inches per minute, this equates to a web solution dispensing of about 1.40 - to- 4.50 grams per inch of linear web travel. The machine is capable of dispensing liquids over a wide range of viscosities ranging between (but not limited to) 1-20,000 centopoise. In the current embodiment, the web speed ranges from about 180" per minute to as high as 900" per minute, however with minor modifications this range can be substantially extended.

The equipment is portable, with clamp locking casters, and is designed to withstand wash-down cleaning procedures. The system is also capable of CIP (clean-in-place) to minimize product changeover time.

The present invention further relates to applying a coating to non-absorbent webs. It is an object of the present invention to helically wrap the wetting tubes within metallic wire such that the subsequent wraps are spaced slightly apart from each other. In operation a web of non-absorbent material would be in contact with the helically wound wire and thus held a fixed distance away from the wetting tube. The spacing between the adjacent wraps allows a thin layer of solution to be applied to the surface of the non-absorbent web. The solution then flows over the surface to form a smooth layer. This technique could be easily combined with known methods of drying the wet solution to form a coating on the non-absorbent web.

Brief Description of Drawings

Figure 1 illustrates a Main Assembly of the present invention.

Figures 2A and 2B illustrate a Slitter Assembly of the present invention.

Figure 3 illustrates a Folding Section Drive Assembly of the present invention.

Figures 4A and 4 B illustrate a Fluid Distribution Cart Assembly of the present invention.

Figure 5 illustrates the fluid system schematics for the solution dispensing system.

Figure 6 illustrates the Application Mode of the present invention.

Figure 7 illustrates the Surge Tank Flush CIP Mode of the present invention.

Figure 8 illustrates the transfer pump circuit mode.

Figure 9 illustrates the tote refill mode.

Figure 10 illustrates the CIP manifold circuit mode.

Figure 11 illustrates a threading system.

Figure 12 illustrates a solution wetting system flow rate chart.

Detailed Description of Invention

Figure 1 shows the overall machine (2) equipped with eight quick change Folding Plate Assemblies (6) through which web of various widths are dispensed from the Unwind Stands (4). Up to eight cloth webs, dispensed from the unwinds and routed over the turning bars provided, are to be grouped into two sets of four webs each.

The present invention can house fewer or more webs. The folding plates can be utilized in varying forms to produce differing web folds.

Each set of up to four webs is routed through the diverging rollers and into the upper and lower folding section levels respectively. The sets are then re-divided into individual webs and routed through their respective S-Wrap Drive Rollers (7), across the Solution Wetting Tubes (10) and Guide Rollers (12), and downward through their respective Folding Plate Assemblies (6)

where the wet webs are folded into "Z", "C", "W" or "e" fold configurations. As the folded webs exit the upper and lower folding assemblies they are layered atop each other on the upper and lower Transfer Conveyors (5). Upon exiting the upper and lower folding section the two sets of four webs are recombined into eight webs via the combining rollers. The system includes a Razor-Slitter/Anvil-Roll Assembly (3) to score-slit a web of closed-cell foam packaging material to longitudinally wrap the stacked folded webs.

Figures 2A and 2B illustrate a Slitter Assembly of the present invention. The Score-Slitting Assembly consists of an Anvil Roll (23) over which the web of packaging material is routed. Four pneumatically actuated Razor Slitters (24) are provided which attach to a Dovetail Mounting Bracket Assembly (21) permanently mounted in near proximity to the Anvil Roll. To permit appropriate placement of the score lines in the packaging material, the lateral position of the slitter assemblies can be adjusted via adjustment screws (27). The scored packaging material web is routed beneath the lowest folded cloth web and is folded longitudinally to wrap the layered folded webs by a separate folding station (not shown).

Figure 3 illustrates a Folding Section Drive Assembly of the present invention. A Serpentine Timing Belt Drive System is utilized to transfer power to the S-Wrap Rolls, Slitter Anvil Roll and Transfer Conveyors. The drive system is connected to a preexisting line shaft with a flat-V belt (32). A variable Pitch Sheave is supplied to provide speed matching to the pre-existing machine sections; however, the system can also be driven via an electric motor or other suitable drive system.

Figures 4A and 4B illustrate the Fluid Distribution Cart Assembly. The system is capable of accommodating up to eight ports from the Supply Manifold to the Wetting Tubes as necessary to apply solution to the correct number of webs. The flow rate for each Wetting Tube is settable from the operator's panel to rates ranging from about 1.40-to-4.50 grams per inch of

linear web travel; the flow rate is automatically adjusted by the PLC (Programmable Logic Controller) control system to compensate for changing web speeds. The system is capable of dispensing solutions ranging in viscosity from about (but not limited to) 1cP to 20,000cP. In an embodiment, all the same solution has to be used on a single web. However, the system can be set up to package webs separately and therefore more than one solution can be used in this embodiment. In an embodiment, software controls the speed versus the dispensing rate. Each of the eight webs can be controlled individually. The product can be weighed on line to see if the correct amount of fluid has been added. Based on the weight of the wetted webs, the flow rate can be adjusted.

The 75-gallon Surge Tank (42) holds the solution pumped from a storage tote, tank, or drum and allows for changeover of storage containers without interrupting operation of the machine. A Flow Meter (44) between the pump and this tank will also verify the amount received -vs.- the amount used. The Flow Meter preceding this tank and the transducer inside this tank allows the material handler to determine that the storage supply tote is empty, via an alarm, and needs to be replaced. Upon reaching the full-tank-limit setting of approximately 70 gallons, the Tote Transfer Pump (46) will turn off. At the low-level-limit setting (approximately 60-65 gallons), the pump will turn on; and with feedback from the transducer inside the tank; continue to run the pump until tank-full-limit setting is reached. When the tank-volume-low-limit setting (approximately 1-2 gallons) is reached the machine will stop automatically as there will be insufficient solution to continue operating.

Tote Transfer Pump (46): returns solution to the product tote from the Surge Tank (42) and serves as the CIP Pump for cleaning the tank. These functions are selectable from the operator's touch screen. Minor hose re-routing is required for CIP operation.

The PLC-based control system has a wide range of functions and is able to monitor all eight Wetting Tube Flow Meters (48) at the manifold, to change settings of the Flow Valves, to turn on/off any of the Flow Valves, monitor the Flow Meter for tote unload, automatic CIP, automatic run, cycle stop, e-stop, etc. During operation the flow rate for each of the eight Wetting Stations being utilized is set from the operator's touch screen. The Material Supply Pump (50) pumps the wetting solution to the supply manifold. The Material Supply Pump also serves as the CIP pump to clean the manifold, and lines. The supply manifold is equipped with eight individual pneumatically actuated control valves to supply wetting solution from the supply manifold to each Wetting Tube. The flow rate for each Wetting Tube is monitored by a Flow Meter that returns a signal to the control system to control the flow rate by adjusting the air pressure in the pneumatic valves.

Solution Dispensing System Description

The solution dispensing system is comprised of four distinct operating modes:

1: Application Mode

2: Surge Tank Drain Mode

3: Surge Tank Flush CIP Mode

4: CIP Pressure Pump and Applicator Mode

Two sub-systems operate, in the background, to supply condition compressed air to each of the pneumatic components via the pneumatic service input; and to provide signal translation to each of the electrical/electronic components via the PLC.

Figure 5 illustrates the fluid system schematics for the solution Dispensing System. These drawings display the solution path and associated control components for each of the operating modes, the total solution path with associated control components; and, the relationship of each of these components to the system-controlling PLC.

Each of these four modes of operation is easily accessible from the touch screen operator's station.

Abbreviation	Component
BV_{01*}	2-way Shut-Off Valve
$FPFC_{01*}$	Fluid Proportional Flow Control Valve
FS_{01*}	Flow Meter
M	Electric Motor
MSP	Material Supply Pump
$PPRV_{01*}$	Proportional Pressure Reducing Valve
PT_{01*}	Pressure Transducer
SV_{01*}	Selector Valve, 3-way
VSD_{01*}	Variable Speed Drive
AM	Air Motor
TTP	Tote Transfer Pump

Note: "*" connotes component number within a series of components *i.e.* SV_{01} represents the first Selector Valve in the series of Selector Valves.

The Tote Transfer Pump Selector Valve is controlled by an electrical signal gathered from data acquired by the PLC. The Tote Transfer Pump produces the solution flow required to fill the Surge Tank and for the Transfer Pump Clean-in-Place operation. The SV_{01} 3-way valve is controlled by the 3-Way Selector Valve #1 [Tote Pump IN], SV_{02} 3-Way Selector Valve #2 [Tote Pump OUT], and SV_{04} 3-way Selector Valve #4 [Surge Tank OUT] by electrical signals generated from data acquired by the PLC. The PLC receives its inputs for its decision-making operations from items selected from the touch screen menus.

Application Mode

When the Application Mode shown in Figure 6, is activated, solution passes from the Main Supply Tote, through BV_{02} and the connecting hose to BV_{01}, which is located on the Solution Dispensing Cart. From BV_{01} the solution passes through valve SV_{01} to the Tote Transfer Pump, where it is pumped through the FS_{02} and SV_{02} and into the Surge Tank. The volume of solution pumped from the Tote to the Surge Tank is measured by the FS_{02} and sent to the PLC. The purpose for the FS_{02} is twofold: to measure and record usage per designated time-period for the solution, and to provide data to the fail-safe permissive data system which prevents the operator from pumping system solution back into a full, or nearly full, Tote during the Surge Tank Drain Mode. The level of solution within the Surge Tank is controlled by PT_{01}, which controls the Tote Transfer Pump in an open loop, binary mode. PT_{01} can be calibrated to control both the "full" and the "fill" levels of the Surge Tank through the PLC.

In the Application Mode, SV_{04} is opened and the solution passes to the MSP where it is pumped to the Solution Distribution Manifold. PT_{02}, located on the Solution Distribution Manifold, senses the solution pressure and controls the MSP operation via its' dedicated- drive module. An orifice, within the manifold tube, bleeds-off the excess volume of solution not distributed to the Wetting Tubes and returns it to surge tank. The solution flow is directed to the Wetting Tubes, each of which may be activated via the proportional Flow Control Valves. Any number of Wetting Tubes may be used for dispensing and folding operations. Flow of solution passes through each Wetting Tube to its respective web.

Each Solution Applicator assembly is identical and is labeled as A-2, 2, 3 & 4 and B-1, 2, 3, & 4. In addition, each assembly contains the following components:

Abbreviation	Component
FPFC $_{01}$	Fluid Proportional Flow Control Valve
FS $_{01}$	Flow Meter
PPRV $_{01}$	Proportional Pressure Reducing Valve

The Solution passes from the Solution Distribution Manifold into the FPFC $_{01}$, through the FS $_{01}$, and to the Wetting Tube. The flow of the solution is sensed by the FS $_{01}$ and is controlled by a closed-loop system. A 4-20mA signal is transmitted from FS $_{01}$ to the PLC and to the PPRV $_{01}$. The signal is translated to a pre-calculated value and is compared to the required set-point. Attempts within the system to deviate from the set-point are modulated by the PPRV $_{01}$ in response to the 4-20mA signal provided to the PLC, which in turn, generates a signal to provide a pressure of 3-15psig to the PPRV $_{01}$. This PID (proportional-integral-differential) control loop maintains the required flow to each Wetting Tube.

Surge Tank Drain Mode

The Surge Tank Drain Mode is an open-loop control system. When the Surge Tank Drain Mode is activated, solution is pumped from the bottom of the Surge Tank through SV $_{04}$ and through SV $_{01}$ by the Tote Transfer Pump through FS $_{02}$, SV $_{02}$, and BV $_{01}$, through the hose connecting to BV $_{02}$ and the Supply Tote. FS $_{02}$ measures the volume of solution passing through it and transmits this data to the PLC, which compares this data to the set-point value of the volume contained in the current Supply Tote. The comparison of data is required to prevent overfilling the Supply Tote.

Surge Tank Flush CIP Mode

The Transfer Pump Clean-in-Place Mode is an open loop operation shown in Figure 7 and is repeated in three sequences with the Pressure Pump and Valve Clean-in-Place operation. At the termination of each of the three sequences, the solution being used for the CIP operation may either be gravity drained from the system, or pumped to drain by the use of the Surge Tank Drain Mode. Components involved in this mode include:

Abbreviation	Component
BV_{02}	Ball Valve, 2-way
$FPFC_{01}$	Fluid Proportional Flow Control Valve
FS_{01}	Flow Meter
MSP	Material Supply Pump
PT_{01}	Pressure Transducer
$SV_{01, 02 \& 04}$	Selector Valve, 3-way

After the introduction of 35 gallons of cleaning solution into the Surge Tank from an external source, the solution is drawn from the bottom of the Surge Tank through SV_{04} and SV_{01} by the Tote Transfer Pump. The cleaning solution is pumped through FS_{02} and SV_{02} to the top of the Surge Tank. A Spray-Ball, installed in the inner top face of the Surge Tank, disperses the cleaning/rinsing solutions to all surfaces of the tank.

The initial sequence utilizes 35 gallons of clean water. The clean water dissolves all solution remaining in this sub-system through a re-circulating process. After a pre-determined length of time, the liquid may either be gravity drained from the system, or pumped to drain by the use of the Surge Tank Drain Mode. This operation is followed by the initial sequence of the CIP Pressure Pump & Applicator Mode (see CIP Pressure Pump and Applicator Mode, below).

CIP Pressure Pump and Applicator Mode

The CIP Pressure Pump & Applicator Mode is an open loop operation, which is also repeated in three sequences. The initial sequence involves 35 gallons of clean water to be introduced into the surge tank from an external source. The clean water dissolves all solution remaining in this sub-system through a re-circulating process. Components involved in this mode include:

Abbreviation	Component
$FPFC_{01}$	Comfort Solution Proportional Flow Control Valve
MSP	Material (Comfort Solution) Supply Pump
PT_{01}	Pressure Transducer
SV_{04}	Selector Valve, 3-way
AA	Applicator Assembly
SDH	Solution Distribution Header
CIPH	CIP Header

After the introduction of 35 gallons of cleaning solution into the Surge Tank, the liquid is drawn from the bottom of the Surge Tank through the SV_{04} by the MSP. The cleaning solution is pumped through the Solution Distribution Manifold into the CIP Manifold and back to the Surge Tank. The solution bleed-off orifice is also cleaned during this operation.

At the termination of each of the three sequences, the cleaning solution being used for the CIP operation may either be gravity drained from the system, or pumped to drain by the use of the Surge Tank Drain Mode.

Three sequences of these operational modes, utilizing water and/or other suitable cleaning and sanitizing agents, has been deemed sufficient to provide an approved sanitary condition of all components contained in these sub-systems.

Figure 8 illustrates the transfer pump circuit mode of the present invention.

Figure 9 illustrates the Tote Refill Mode of the present invention.

Figure 10 illustrates the CIP manifold circuit mode of the present invention.

Figure 11 illustrates the threading system of the present invention. The threading system comprises merge rolls 60 and a hold down pinch roll assembly 62.

Figure 12 illustrates a solution wetting system flow rate chart.